A PECULIAR PROCESS OF SULPHUR DEPOSITION

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The sulphur deposits of Japan have four different modes of origin: sublimation, impregnation, flow, and deposition in lakes. They are all doubtless of solfataric origin. The first two types are common everywhere around volcanic craters, but flows of sulphur are found, so far as the writer knows, only at Rausu, Hokkaido, and Tsurugisan, Rikuchu.

The lake type is very peculiar and unusual. Most of the productive sulphur mines of Japan are operated in deposits which are nearly circular in outline. Some of them which are stratified attain a thickness of 30 meters, and are overlaid by fine brown clayey or tufaceous substances which were derived partly from the surrounding rocks and partly from the sulphur itself.

The characteristic topography of the majority of these Japanese sulphur beds clearly shows that they were formed by deposition from crater lakes. The method of formation, however, appears to have been entirely different from that which produced the "gypsum" type of Sicily, Louisiana, and other places, for some were undoubtedly produced by a method similar to that which is now producing sulphur in a crater on Kunashiri, the southwestern of the Kurile Islands, nearest Hokkaido.

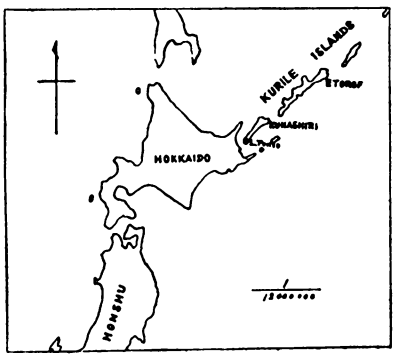

FIG. 1.—Sketch map of Hokkaido and the southern part of the Kurile Islands.

In the southwestern part of Kunashiri is Lake Ichibishinai, a crater lake 1 kilometer in diameter and 150 meters above the level of the sea. South of this lake, and 7 meters higher in elevation, there is a small circular lake

called Ponto. This small lake is 210 meters in diameter and occupies an explosion crater. When this is quiescent, the depth of the lake is from 30 to 35 meters in the center, but during periods of activity it is 30 meters deeper. Toward the margins the lake becomes abruptly shallower, as shown in Fig. 2.

The water of the lake is strongly acidic, and has a temperature of 40° C. Around the margins, through innumerable small fissures, sulphur is deposited, and the country rock is strongly impregnated with it. That the fissures extend beneath the surface of the water is clearly shown by the bubbles of gas which rise to the surface of the lake in various places. The amount of gas emitted is ordinarily not very great, but during periods of low barometric pressure enormous quantities escape. Not only do the fissures emit gas, but the conduit of the crater itself is active, and during the months of February, June, July, and August, when the barometer is low in this vicinity, periodic eruptions of hot water and gas take place.

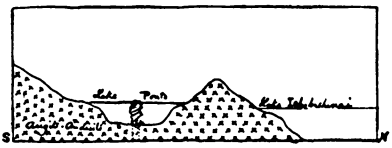

FIG. 2.—Profile of Lake Ponto and Lake Ichibishinai.

During the writer's visit to this locality in August, 1912, paroxysmal eruptions of gas and water were noticed near the center of the lake at intervals of from one to three hours, and whenever the bubbling began workmen rowed to the spot. By means of a pulley attached to a framework resting upon two boats, the men lowered a cylindrical iron bucket, with a capacity of about 140 liters, in the center of the bubbling area to the bottom of the lake. When the bucket was withdrawn, it was practically filled with sulphur grains which were formed by the union of the gases with the water in the lower part of the conduit. Being specifically heavier than water, the sulphur grains, forced upward by the ebullition, sank toward the bottom and into the bucket. In this manner, while the crater is active, a hundred buckets of sulphur are easily brought up in a day.

The greater part of the sulphur is dark gray in color, but some is yellow. The grains are hemispherical, oval, kidney-, fig-, or

spindle-shaped (Fig. 3), and they are usually about 0.2 to 3.0 mm. in diameter. The grains are not solid, but hollow, and the cell walls, which are usually rough on the outside on account of a coating of impurities and of very minute sulphur particles, are so thin that they are very easily broken. In fact, many of the larger grains are broken by mutual impact in the water. In the flat side of many of the hemispherical forms or at one end of those that are round there is a small hole, which was made by the exit of the gases which remained within it after it was formed. Most of the grains are brought up as distinct individuals, but in some cases they are united in large botyroidal masses. On account of their thin shells, they cannot keep their original forms if even slight pressure is applied, and the sunshine also destroys them.

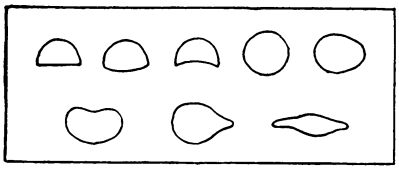

FIG. 3.—Forms of sulphur grains

Two modes of origin of the sulphur in solfataras have been suggested by geologists and chemists: first, the oxidation of hydrogen sulphide, probably according to the equation

$$2H_2S+O_2=2H_2O+2S,$$

secondly, the mutual reaction of hydrogen sulphide and sulphur dioxide, according to the equation

$$2H_2S+SO_2=3S+2H_2O.$$

The hydrogen sulphide and sulphur dioxide, emanating from the conduit, form numberless bubbles in the lake, and where they are in contact with the water the sulphur is deposited. Thus, layer after layer of sulphur may accumulate in a lake and bedded deposits be formed.

Similar oölitic sulphur grains are being formed at the present time in the crater lakes of Shirane[1] and Noboribetsu, but they are not being worked.

[1] H. Kawasaki, *Jour. Tokyo Geol. Society*, No. 122.